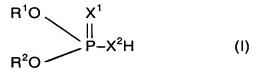
- 1. (currently amended) A method of lubricating an internal combustion engine and improving the efficiency of the emissions control system of the engine, the emissions control system being equipped with a catalyst containing exhaust gas after treatment device, the method comprising:
- (A) selecting a lubricating oil composition comprising: a base oil; an alkali or alkaline earth metal-containing detergent; a metal salt of one or more phosphorus-containing compounds represented by the formula



wherein in formula (I), X¹ and X² are independently O or S, and R¹ and R² are independently hydrocarbyl groups, the average total number of carbon atoms in R¹ and R² for the one or more phosphorus-containing compounds being at least 10.4, wherein up to about [[43]] 40 percent of all the R¹ and R² groups supplied by the phosphorus-containing metal salt contain 4 or fewer carbon atoms; and an acylated nitrogen containing compound having at least about 10 aliphatic carbon atoms and a TBN of at least about 2; the lubricating oil composition being characterized by a phosphorus concentration of up to about 0.12% by weight and the substantial absence of copper;

- (B) adding the lubricating oil composition to the engine;
- (C) operating the engine;
- (D) generating a lean-phosphorus containing exhaust gas; and
- (E) contacting the catalyst in the exhaust gas after treatment device with the lean-phosphorus containing exhaust gas.
- 2. (previously presented) The method of claim 1 wherein during step (A) the weight ratio of detergent metal to phosphorus in the lubricating oil composition is from about 0.5:1 to about 10:1.
- 3 (previously presented) The method of claim 1 wherein the lubricating oil composition has a viscosity of up to about 16.3 mm²/s (cSt) at 100 °C.

- 4. (previously presented) The method of claim 1 wherein the base oil comprises a mineral oil.
- 5. (previously presented) The method of claim 1 wherein the base oil comprises a poly-alpha-olefin or an oil derived from Fischer-Tropsch synthesized hydrocarbons or mixtures thereof.
- 6. (previously presented) The method of claim 1 wherein in formula (I), X^1 and X^2 are each S, and R^1 and R^2 are independently alkyl or alkenyl groups of about 6 to about 18 carbon atoms.
- 7. (previously presented) The method of claim 1 wherein in formula (I), X^1 and X^2 are each S, and R^1 and R^2 are aromatic groups.
- 8. (previously presented) The method of claim 1 wherein the metal used in the metal salt of a phosphorus containing compound is zinc.
- 9 (previously presented) The method of claim 1 wherein at least about 80% by weight of the phosphorus present in the lubricating oil composition is present in a compound represented by formula (I) wherein R¹ and R² are independently hydrocarbyl groups of about 6 to about 18 carbon atoms.
- 10. (previously presented) The method of claim 1 wherein the alkali or alkaline earth metal-containing detergent is a salt of an organic sulfur acid, carboxylic acid, lactone, phenol, or hydrocarbyl substituted saligenin.
- 11. (previously presented) The method of claim 1 wherein the alkali or alkaline earth metal-containing detergent is a salt of a linear oligomer or polymer containing unsubstituted or substituted phenol units and unsubstituted or substituted salicylic units.
- 12. (previously presented) The method of claim 1 wherein the alkali or alkaline earth metal is sodium, lithium or calcium.
- 13. (previously presented) The method of claim 1 wherein the acylated nitrogen-containing compound is derived from a carboxylic acylating agent and at

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least one amino compound containing at least one -NH- group, the acylating agent being linked to the amino compound through an imido, amido, amidine or salt linkage.

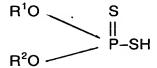
- 14. (previously presented) The method of claim 1 wherein the acylated nitrogen containing compound is a polyisobutene substituted succinimide.
- 15. (previously presented) The method of claim 1 wherein the lubricating oil composition further comprises a dispersant, corrosion-inhibiting agent, antioxidant, viscosity modifier, dispersant viscosity index modifier, pour point depressant, friction modifier, anti-wear agent, extreme pressure agent, fluidity modifier, copper passivator, anti-foam agent, or a mixture of two or more thereof.
- 16. (previously presented) The method of claim 1 wherein the lubricating oil composition is characterized by the substantial absence of magnesium.
- 17. (currently amended) A method of lubricating an internal combustion engine and improving the efficiency of the emissions control system of the engine, the emissions control system being equipped with a catalyst containing exhaust gas after treatment device, the method comprising:
- (A) selecting a lubricating oil composition comprising: a base oil; an alkali or alkaline earth metal-containing detergent, the alkali or alkaline earth metal being sodium, lithium or calcium; a zinc salt of a phosphorus-containing compound represented by the formula

$$R^{1}O$$
 S \parallel $P-SH$ (II)

wherein R^1 and R^2 independently hydrocarbyl groups, the average total number of carbon atoms in R^1 and R^2 for the one or more phosphorus-containing compounds being at least 10.4, wherein up to about [[43]] <u>40</u> percent of all the R^1 and R^2 groups supplied by the phosphorus-containing metal salt contain 4 or fewer carbon atoms; at least about 80% by weight of the phosphorus present in the lubricating oil composition being present in a compound represented by formula (II) wherein R^1 and R^2 are independently hydrocarbyl groups of about 6 to about 18 carbon atoms;

and a polyisobutene substituted succinimide having a TBN of about 5 to about 30, the polyisobutene substituent having a number average molecular weight in the range of about 700 to about 3000; the lubricating oil composition being characterized by a phosphorus concentration of no more than about 0.12% by weight and the substantial absence of copper;

- (B) adding the lubricating oil composition to the engine;
- (C) operating the engine;
- (D) generating a lean-phosphorus containing exhaust gas; and
- (E) contacting the catalyst in the exhaust gas after treatment device with the lean-phosphorus containing exhaust gas.
- 18. (previously presented) A method of lubricating an internal combustion engine and improving the efficiency of the emissions control system of the engine, the emissions control system being equipped with a catalyst containing exhaust gas after treatment device, the method comprising:
- (A) selecting a lubricating oil composition comprising: a base oil; an alkali or alkaline earth metal-containing detergent, the alkali or alkaline earth metal being sodium, lithium or calcium; a zinc salt of a phosphorus-containing compound represented by the formula



wherein R¹ and R² are 4-methyl-2-pentyl; and a polyisobutene substituted succinimide having a TBN of about 5 to about 30, the polyisobutene substituent having a number average molecular weight in the range of about 700 to about 3000; the lubricating oil composition being characterized by a phosphorus concentration of no more than about 0.12% by weight and the substantial absence of copper;

- (B) adding the lubricating oil composition to the engine;
- (C) operating the engine;
- (D) generating a lean-phosphorus containing exhaust gas; and
- (E) contacting the catalyst in the exhaust gas after treatment device with the lean-phosphorus containing exhaust gas.

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- 19. (previously presented) The method of claim 1 wherein less than 34 mole percent of all the R¹ and R² groups supplied by the phosphorus-containing metal salt contain 4 or fewer carbon atoms.
- 20. (previously presented) The method of claim 1 wherein the lubricating oil composition is characterized by a phosphorus content of up to about 0.08 percent by weight phosphorus.
- 21. (previously presented) The method of claim1 wherein from about 16 to about 34 percent of all the R¹ and R² groups supplied by the phosphorus-containing metal salt contain 4 or fewer carbon atoms.
- 22. (previously presented) The method of claim1 wherein up to about 40 percent of all the R^1 and R^2 groups supplied by the phosphorus-containing metal salt contain 4 or fewer carbon atoms and at least 60 mole percent of all the R^1 and R^2 groups supplied by the phosphorus-containing metal salt are derived from secondary alcohols.
- 23. (previously presented) The method of claim1 wherein about 16 to about 34 percent of all the R^1 and R^2 groups supplied by the phosphorus-containing metal salt contain 4 or fewer carbon atoms and at least 60 mole percent of all the R^1 and R^2 groups supplied by the phosphorus-containing metal salt are derived from secondary alcohols.
- 24. (previously presented) A method of lubricating an internal combustion engine and improving the efficiency of the emissions control system of the engine, the emissions control system being equipped with a catalyst containing exhaust gas after treatment device, the method comprising:
- (A) selecting a lubricating oil composition comprising: a base oil; an alkali or alkaline earth metal-containing detergent; a metal salt of one or more phosphorus-containing compounds represented by the formula

$$R^{1}O X^{1}$$

$$\parallel P-X^{2}H \qquad (I)$$

wherein in formula (I), X¹ and X² are independently O or S, and R¹ and R² are independently hydrocarbyl groups, the average total number of carbon atoms in R¹ and R² for the one or more phosphorus-containing compounds is at least 10.4, up to about 40 percent of all the R¹ and R² groups supplied by the phosphorus-containing metal salt contain 4 or fewer carbon atoms, and at least 60 mole percent of all the R¹ and R² groups supplied by the phosphorus-containing emtal salts are derived from secondary alcohols; and an acylated nitrogen containing compound having at least about 10 aliphatic carbon atoms and a TBN of at least about 2; the lubricating oil composition being characterized by a phosphorus concentration of up to about 0.12% by weight and the substantial absence of copper;

- (B) adding the lubricating oil composition to the engine;
- (C) operating the engine;
- (D) generating a lean-phosphorus containing exhaust gas; and
- (E) contacting the catalyst in the exhaust gas after treatment device with the lean-phosphorus containing exhaust gas.